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(p. iii), and again, if the conclusions "be true, we stand . . . on the threshold of a very important research in meteorology" (p. v).

The daily solar measurements made at Calama, Chile, by the Smithsonian Institution, were transmitted to Buenos Aires, at first by mail and then by cable, and were used for forecasting purposes from early December, 1918. By the correlation method, as well as by the method of direct comparison, Mr. Clayton compared all the observations of solar radiation made by the Smithsonian Institution, both at Calama and at Mt. Wilson, with the temperatures and rainfall of Argentina. Further comparisons were also made, in an earlier paper, between the weather in remote parts of the world and the Mt. Wilson observations. It is impossible, in a brief note such as this, to follow Mr. Clayton's very careful and painstaking research in detail. Briefly, his main conclusion is (1) "that if there were no variation in solar radiation the atmospheric motions would establish a stable system with exchanges of air between equator and pole and between ocean and land in which the only variations would be daily and annual changes set in operation by the relative motions of the earth and sun; (2) the existing abnormal changes which we call weather have their origin chiefly, if not entirely, in the variation of solar radiation." During the summer, high values of solar radiation are followed, a few days later, by high temperatures at Buenos Aires, and decreases in solar radiation are followed by rain. In winter, the relation is different, increases of solar intensity being followed three to five days later by rising pressure and cooler weather in Argentina. A detailed study of the lengths of the periods of solar radiation shows that "there is a distinct tendency to form periods around certain lengths," e.g. 3.5 to 3.7 days, 4.9 to 5.3, etc., up to 30 to 34 days. At Buenos Aires the ratio of change of temperature to solar change at the time of maximum solar activity was found, from several years' averages, to be 1.4°C. for each change of 1 per cent of solar radiation. The extreme solar values range about 6 per cent on either side of the mean. Hence departures of about 8.5°C. from the normal at Buenos Aires might result from this cause. Maps are given showing the rainfall on five successive days during which there was a complete daily solar record. On the average, the rainfall follows a solar decrease after about three days in southern Buenos Aires and the Pampa, and after about five days from Corrientes to Tucumán.

The whole investigation is one of the most striking, and is surely one of the most important, which has been brought to the attention of meteorologists in recent years. For about three decades Mr. Clayton has been devoting himself largely to the question of the improvement of daily weather forecasts. With the help of the Smithsonian Institution he has now been able to strike out on a new path, and his conclusions seem destined to revolutionize the whole business of forecasting. Mr. Clayton is not prone to make statements for which he has no good and sufficient scientific basis. Meteorologists, and scientific men generally, may therefore well pay attention to the following: "These studies, it is believed, will permit the prediction of the weather with a fair degree of accuracy for much longer intervals in advance than three days and may perhaps extend them to weeks or years" (p. 52).

R. DEC. WARD

A NEW STANDARD MANUAL OF METEOROLOGY

NAPIER SHAW. **Manual of Meteorology. Part IV: The Relation of the Wind to the Distribution of Barometric Pressure.** xvi and 166 pp., maps, diagrs., ills., index. *M[eteorol.] O[ffice Publ. No.] 234*, London, 1919. 12s., 6d. 10 x 7 inches.

This fourth part of what doubtless, when complete, will be for a few years the leading reference book on meteorology is a direct outcome of the war. Quite early in the struggle it began to dawn upon those charged with offensive and defensive operations that some knowledge of the structure of the atmosphere was desirable and might even prove helpful. When evidence began to accumulate that the enemy, not only in his offensive air campaign but also in the execution of land and sea operations, had his meteorologists at work and was gaining much thereby, there came hurried calls upon the British Meteorological Office for data about the winds, at the surface, at moderate elevations, and at the great heights. The naval, military, and air services sent in their questions; and one may well imagine that Sir Napier Shaw and his staff had their hands full. It is a fact that, before the war, surface winds only were considered in gunnery and that upper air conditions were unnoticed. This is only one illustration of the sudden awakening which came in 1914 and 1915.

The present volume was issued in advance of Parts I, II, and III because there was much material at the Meteorological Office which had not heretofore been collected and gathered up in available form. Part I, when it appears, will attempt a general survey of the globe based largely on the work of Teisserenc de Bort and Hildebrandsson. Part II will be perhaps the most vital section, dealing with the thermodynamics of moist air; and Part III will formally set forth the dynamics and kinematics which find their application in the problems discussed in Part IV.

The first broad generalization which Sir Napier Shaw employs is that in the free atmosphere the air obeys very closely the laws of motion under balanced forces, the forces depending upon the earth's spin and a small circle spin of the air. In the upper air, rather than at the surface, we find the true relation between pressure and wind. In fact, if the surface wind be taken as the basis of computation, we cannot express in one equation the relation between wind and pressure gradient, representing the underlying principle upon which Buys Ballot's law depends. Taking it, then, as established that the wind at the 500-meter level satisfies the surface pressure-gradients, the first striking development is that in an anticyclone, the curvature of the isobars being great, the winds near the center must be light; which seems to be true in nature; while on the other hand there is practically no limit to the velocity of the wind in small circles, as near the core of a tropical revolving storm or a tornado.

This explains what Shaw has in mind by motion under balanced forces. Air must be regarded as traveling over long tracks of sea and land with very little change of velocity from hour to hour. Even such an incident as being caught in the ascending current of a rainstorm is after all but a small thing in the life history of an air current. The greater part is made up of such steady motion as we see in clouds journeying long distances with little change in speed. The true function of the pressure distribution is to *steer the air* rather than to speed it or stop it. And having once assumed this "strophic" balance to be true, we may call one factor in the equation for gradient wind "geostrophic," due to the earth's spin, and the other "cyclotrophic."

The first six chapters treat of variations of wind with height; eddy motion and Taylor's theory of diffusion of eddy motion based on the analogous diffusion of heat by conduction; turbulence in relation to gustiness and cloud sheets; föhn and chinook winds; variations of vertical velocities, from pilot-balloon observations; and the structure of the upper layers of the atmosphere.

The other five chapters deal more directly with storm movements. In Chapter 9 we are given maps showing the flow of the air at sea level, 305 meters (1,000 feet), 1524 meters (5,000 feet), 3,048 meters (10,000 feet), 4,572 meters (15,000 feet), and 6,096 meters (20,000 feet) at midday October 19, 1917, that being the date when a very strong wind in the upper air carried a fleet of Zeppelins out of their course and once and for all lost to Germany that supremacy in the air which was counted upon to offset the British supremacy on the sea. This was due to the rapid approach of a second "low," with strong southerly winds, in the rear of another "low," passing eastward. What happened was this. On the western side of the first "low" there was a sudden increase of northerly winds above the two-kilometer level. This persistent wind blowing probably 20 meters per second (45 miles per hour) carried the fleet too far south, into the lines of the enemy.

Chapter 10 deals with curved isobars, i.e. revolving polar caps and bands of air flow that maintain themselves for days. One further type, of greatest interest to forecasters, is rotation around a center in circles of relatively small radius; that is, our familiar cyclones. Evidence of stability in motion of this character is found in all circular storms, from the little "dust devils," lasting but a few minutes, through whirlwinds, tornadoes, typhoons, *baguios*, hurricanes, and cyclones, and up to the revolving cap covering a hemisphere.

A fine example is found in the tropical revolving storm charted by the present reviewer (see Fig. 1 in his article on "Wandering Storms" in this issue), which started on a westerly track towards the Philippine Islands (these storms are called by the Manila Observatory *baguios*), then, recurving, crossed the Pacific Ocean and the North American continent, and ultimately was lost south of Iceland. The whole journey lasted from November 20, 1895, to January 22, 1896. This storm, therefore, went halfway around the world.

Finally, Shaw gives us an analysis of the nature of cyclonic depressions, corrections of anemograms for exposure, and some special cases of cyclonic action in the British Isles. Incidentally it appears that the old notion that variations of temperature at the surface are the initial causes of cyclonic circulation must be scrapped. There are too many known cases of convective heavy rains without consequent circulation.

The book is well printed; the illustrations are clear and properly placed. When we recall that most of the work of preparation must have been done during the stress of war, certainly a large measure of commendation must go to Mr. J. B. Peace, Printer to the University of Cambridge, an old friend and colleague of Sir Napier's.

ALEXANDER MCADIE